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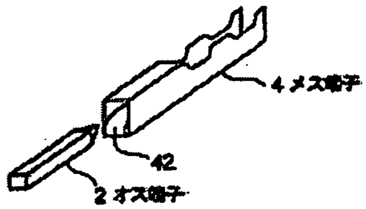
(54) [Title of the Invention] A Forming and Heat Treatment Method for Copper Alloys for Electric Connector Parts and a Copper Alloy for Electric Connector Parts

(57) [Abstract]

[Problem] The problem is a forming and heat treatment method for an electric connector material with spring properties and a copper alloy for electric connector parts.

[Means of Solution] This is a method of forming and heat treatment of copper alloys used for electric connector parts, which is a method of forming and heat treatment of copper alloys for electric connector parts in which the forming process precedes the heat treatment. This copper alloy for electric connector parts is formed from the raw material into a spring and is formed so that the change in the Vickers hardness (Hv) of the formed spring site before and after this forming process is kept to less than 10. Next, at the time heat treatment is performed, the change in Vickers hardness (Hv) of the spring site before and after said heat treatment is kept to less than 10. It is preferred that said heat treatment be performed for 5 to 10,000 seconds at a temperature of 200 to 800°C.

(A)



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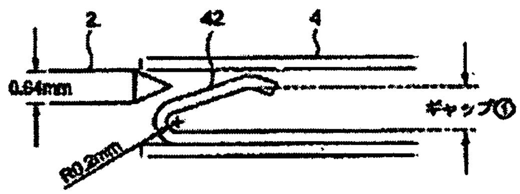


(A)
4 – female terminal
2 – male terminal

(B)
(1) gap

[Claims]

[Claim 1] A method of forming and heat treatment of copper alloys for electric connector parts which is a method of forming and heat treatment of copper alloys for electric connector parts in which molding forming and subsequently heat treatment are performed, characterized in that the copper alloy for electric connector parts is formed from the raw material into a spring and is formed so that the change in the Vickers hardness (Hv) of the processed site before and after forming is kept to less than 10, and, next, at the time heat treatment is performed, the change in Vickers hardness (Hv) of the spring site before and after said heat treatment is kept to less than 10.

[Claim 2] The method of forming and heat treatment of copper alloys for electric connector parts as described in claim 1, further characterized in that the heat treatment following said molding forming is performed for 5 to 10,000 seconds at a temperature of 200 to 800°C.

[Claim 3] A copper alloy for electric connector parts that is formed so that the change in Vickers hardness (Hv) of the formed site before and after molding forming of the raw material into a spring is kept to less than 10 and that contains either one or two or more of the components listed below, for the purpose, at the time the heat treatment is performed, of keeping the change of Vickers hardness (Hv) of the aforementioned spring site before and after said heat treatment to less than 10, the balance being comprised of Cu and unavoidable impurities ("0 wt%" indicated below signifying no addition).

Sn: 0-10 wt%	Zn: 0-40 wt%	Ni: 0-10 wt%
Fe: 0-3 wt%	Cr: 0-1 wt%	Mn: 0-1 wt%
P: 0-0.5 wt%	Si: 0-1 wt%	Mg: 0-1 wt%

Zr: 0-0.5 wt%　Ti: 0-1 wt%　Co: 0-1 wt%

Ag: 0-1 wt%　Al: 0-5 wt%　B: 0-0.5 wt%

rare-earth elements: 0-0.5 wt%

[Claim 4] The copper alloy for electric connector parts as described in claim 3, further characterized in that the heat treatment that is performed following said molding forming is conducted for 5 to 10,000 seconds at a temperature of 200 to 800°C.

[Claim 5] The copper alloy for electric connector parts as described in claim 3 or 4, further characterized in that said alloy for electric connector parts is a copper alloy that is comprised of 1 to 4 wt% Ni and 0.1 to 1.0 wt% Si, with the balance being Cu and unavoidable impurities.

[Claim 6] The copper alloy for electric connector parts as described in claim 3 or 4, further characterized in that said alloy for electric connector parts is a copper alloy that contains 1 to 4 wt% Ni, 0.1 to 1.0 wt% Si, and, in addition, one or more elements selected from Sn, Mn, Mg, Zn, Ag and Co for a total amount of 0.005 to 1 wt% and that the balance is comprised of Cu and unavoidable impurities.

[Claim 7] The copper alloy for electric connector parts as described in claim 3 or 4, further characterized in that said alloy for electric connector parts is a copper alloy that is comprised of 0.5 to 3 wt% Sn and 0.005 to 0.5 wt% P, the balance being Cu and unavoidable impurities.

[Claim 8] The copper alloy for electric connector parts as described in claim 3 or 4, further characterized in that said alloy for electric connector parts is a copper alloy that contains 0.5 to 3 wt% Sn and 0.005 to 0.5 wt% P. and, in addition, one or more elements

selected from Ni, Mn, Fe, Cr, Mg and Zn for a total amount of 0.005 to 2 wt%, the balance being comprised of Cu and unavoidable impurities.

[Claim 9] The copper alloy for electric connector parts as described in claim 3 or 4, further characterized in that said alloy for electric connector parts is a copper alloy that is comprised of 3 to 10 wt% Sn and 0.005 to 0.5 wt% P, the balance being comprised of Cu and unavoidable impurities.

[Claim 10] The copper alloy for electric connector parts as described in claim 3 or 4, further characterized in that said alloy for electric connector parts is a copper alloy that contains 3 to 10 wt% Sn and 0.005 to 0.5 wt% P, and, in addition, one or more elements selected from Ni, Fe and Zn for a total amount of 0.005 to 2 wt% and that the balance is comprised of Cu and unavoidable impurities.

[Claim 11] The copper alloy for electric connector parts as described in claim 3 or 4, further characterized in that said alloy for electric connector parts is a copper alloy that is comprised of 5 to 35 wt% Zn, and, as the balance, Cu and unavoidable impurities.

[Claim 12] The copper alloy for electric connector parts as described in claim 3 or 4, further characterized in that said alloy for electric connector parts is a copper alloy that contains 5 to 35 wt% Zn, and, in addition, one or more elements selected from Sn, Ni and Fe, the balance being comprised Cu and unavoidable impurities.

[Detailed Description of the Invention]

[0001]

[Field of industrial use] This invention relates to a forming and heat treatment method for copper alloys for electric connector parts containing a spring that are used in electric terminals and switches and to this copper alloy for electric connector parts.

[0002]

[Prior art] Parts for electric connector materials utilizing the spring characteristics of metal materials are common components. The mechanism of electric connection of terminals and switches in almost all cases is to obtain an electrical connection by establishing firm contact between the companion materials by means of the spring properties of metals. Box-type terminals, which are frequently used in automobiles, typically have a structure as shown in Figure 1 in which the tongue piece 42 of the female terminal 4 plays the role of the spring, the spring being deflected when the male terminal 2 is inserted and contact force with the male terminal 2 is obtained by its reaction force.

[0003] Various approaches have been taken in order to increase the reliability of electric contact points. For example, such methods as surface modification by plating and increasing the contact force (hereafter referred to as contact pressure) have been widely used. This contact pressure is ordinarily not fixed constant and "sagging" in the spring component occurs due to repeated insertion and withdrawal. There are cases in which sufficient contact pressure is not obtained and there are many cases in which creeping of the metal component occurs and contact pressure gradually decreases (stress relaxation phenomenon).

[0004] In particular, as devices have become smaller in recent years, electric connectors themselves have also become smaller and thinner and the plate thickness of the metal plate materials that are used has become thinner. When the same contact

pressure is to be obtained, it is necessary to increase the amount of deflection of the thinner plate material, but the maximum stress that is applied to the plate material may be increased to an order that is unsupportable, in comparison to previous components. As a result, sagging readily occurs due to repeated insertion and withdrawal.

[0005] Further, connectors for automobiles in particular are subjected to high environmental temperatures and are in states in which stress relaxation readily occurs. In view of such states in which changes in contact pressure readily occur over time, high initial contact pressure has been especially designed so that a contact pressure of the required minimum limit can be maintained over a long period.

[0006] There has also been a tendency toward an increase in the number of connector poles because of an increase in the number of input-output terminals. That is, even if there is only a slight increase in the contact pressure of paired connectors, with multipole connectors, there is a great change in the insertion and withdrawal force required when the connectors are inserted and withdrawn. For example, during the assembly of an automobile, connectors are usually fitted together by hand. When the insertion and withdrawal force is increased, the load during assembly is increased and there is deterioration of operational efficiency.

[0007] At present, we are caught in the dilemma of the contradictory demands of wanting to increase the initial contact pressure, but needing to control the insertion and withdrawal force at a low level. Of course, in order to control the insertion force at a low level while maintaining the high contact pressure as is, a surface modification is performed for the purpose of obtaining a low coefficient of friction. However, no

technology has been developed for establishing both electrical reliability and a low coefficient of friction.

[0008]

[Problems the invention is intended to solve] In light of this, the object of this invention is to provide a metal spring component for electric connector parts with which initial contact pressure is not increased and there is little change in contact pressure over time.

[0009]

[Means for solving the problems] The first subject of the invention is a method of forming and heat treatment of copper alloys for electric connector parts which is a method of forming and heat treatment of copper alloys for electric connector parts in which molding forming and subsequently heat treatment are performed, characterized in that the copper alloy for electric connector parts is formed from the raw material into a spring and is formed so that the change in the Vickers hardness (Hv) of the processed site before and after forming is kept to less than 10, and, next, at the time heat treatment is performed, the change in Vickers hardness (Hv) of the spring site before and after said heat treatment is kept to less than 10.

[0010] The second subject of the invention is a method of forming and heat treatment of copper alloys for electric connector parts, characterized in that the heat treatment following said molding forming is performed for 5 to 10,000 seconds at a temperature of 200 to 800°C.

[0011] The third subject of the invention is a copper alloy for electric connector parts that is formed so that the change in Vickers hardness (Hv) of the formed site before

and after molding forming of the raw material into a spring is kept to less than 10 and that contains either one or two or more of the components listed below, for the purpose, at the time the heat treatment is performed, of keeping the change of Vickers hardness (Hv) of the aforementioned spring site before and after said heat treatment to less than 10, the balance being comprised of Cu and unavoidable impurities ("0 wt%" indicated below signifying no addition).

Sn: 0-10 wt%	Zn: 0-40 wt%	Ni: 0-10 wt%
Fe: 0-3 wt%	Cr: 0-1 wt%	Mn: 0-1 wt%
P: 0-0.5 wt%	Si: 0-1 wt%	Mg: 0-1 wt%
Zr: 0-0.5 wt%	Ti: 0-1 wt%	Co: 0-1 wt%
Ag: 0-1 wt%	Al: 0-5 wt%	B: 0-0.5 wt%

rare earth elements: 0-0.5 wt%

[0012] The fourth subject of the invention is a copper alloy for electric connector parts, characterized in that the heat treatment that is performed following said molding forming is conducted for 5 to 10,000 seconds at a temperature of 200 to 800°C.

[0013] The fifth subject of the invention is a copper alloy for electric connector parts, characterized in that the aforementioned alloy for electric connector parts is a copper alloy that is comprised of 1 to 4 wt% Ni and 0.1 to 1.0 wt% Si, with the balance being Cu and unavoidable impurities.

[0014] The sixth subject of the invention is a copper alloy for electric connector parts, characterized in that said alloy for electric connector parts is a copper alloy that contains 1 to 4 wt% Ni, 0.1 to 1.0 wt% Si, and, in addition, one or more elements selected

from Sn, Mn, Mg, Zn, Ag and Co for a total amount of 0.005 to 1 wt% and that the balance is comprised of Cu and unavoidable impurities.

[0015] The seventh subject of the invention is a copper alloy for electric connector parts, characterized in that said alloy for electric connector parts is a copper alloy that is comprised of 0.5 to 3 wt% Sn and 0.005 to 0.5 wt% P, the balance being Cu and unavoidable impurities.

[0016] The eighth subject of the invention is a copper alloy for electric connector parts, characterized in that said alloy for electric connector parts is a copper alloy that contains 0.5 to 3 wt% Sn and 0.005 to 0.5 wt% P. and, in addition, one or more elements selected from Ni, Mn, Fe, Cr, Mg and Zn for a total amount of 0.005 to 2 wt%, the balance being comprised of Cu and unavoidable impurities.

[0017] The ninth subject of the invention is a copper alloy for electric connector parts, characterized in that said alloy for electric connector parts is a copper alloy that is comprised of 3 to 10 wt% Sn and 0.005 to 0.5 wt% P, the balance being comprised of Cu and unavoidable impurities.

[0018] The tenth subject of the invention is a copper alloy for electric connector parts, characterized in that said alloy for electric connector parts is a copper alloy that contains 3 to 10 wt% Sn and 0.005 to 0.5 wt% P, and, in addition, one or more elements selected from Ni, Fe and Zn for a total amount of 0.005 to 2 wt% and that the balance is comprised of Cu and unavoidable impurities.

[0019] The eleventh subject of the invention is a copper alloy for electric connector parts, characterized in that said alloy for electric connector parts is a copper

alloy that is comprised of 5 to 35 wt% Zn, and, as the balance, Cu and unavoidable impurities.

[0020] The twelfth subject of the invention is a copper alloy for electric connector parts characterized in that said alloy for electric connector parts is a copper alloy that contains 5 to 35 wt% Zn, and, in addition, one or more elements selected from Sn, Ni and Fe, the balance being comprised of Cu and unavoidable impurities.

[0021]

[Embodiments of the invention] It is necessary that the spring characteristics of copper alloys for electric connector parts are superior. Spring characteristics are evaluated by spring limit value. This is the bending stress value corresponding to the yield strength found from tensile tests and is defined as follows. The spring limit value (Kb) is the maximum surface stress that produces permanent deformation equal to the elastic deformation when the surface stress due to bending becomes $3E/8 \times 10^4$.

[0022] Low temperature annealing is generally known as a method for increasing the spring limit value. The reason that low temperature annealing increases the spring limit value is thought to be because the dislocation that is produced by plastic forming before the low temperature annealing is rearranged by heat treatment. Accordingly, in this invention a suitable degree of plastic forming is provided in advance to cause disorder of the orientation of the dislocation, after which a suitable low temperature annealing is provided so that a copper alloy for electric connector parts which exhibits superior spring characteristics can be obtained.

[0023] The basic embodiment of the invention is a forming and heat treatment method which is a method of forming and heat treatment of copper alloys for electric

connector parts in which molding forming and subsequent heat treatment are performed in which the copper alloy for electric connector parts is formed from a raw material such as a plate or rod-wire into a spring and is formed so that the change in the Vickers hardness (Hv) of the formed spring site before and after forming is kept to less than 10, and, next, at the time heat treatment is performed, the change in Vickers hardness (Hv) of said site before and after said heat treatment is kept to less than 10. When the degree of spring forming is set and when the specified forming is performed by suitable plastic forming or heat treatment in advance, the change in hardness is regulated so that it is less than 10.

[0024] When bending processing of the site that acts as a spring is performed, processing and hardening occur and there is a change in Vickers hardness (Hv). When the change in the hardness of said site exceeds 10, the spring characteristics cannot be sufficiently improved by the heat treatment that is performed subsequently. The reason for this is that sufficient reorientation of the dislocation cannot be effected by subsequent low temperature annealing.

[0025] Next, we shall explain the reason why the heat treatment temperature is generally limited to 200 to 800°C for the condition of low temperature annealing as the heat treatment. When the temperature is less than 200°C, the characteristics of the spring component cannot be improved. When the temperature exceeds 800°C, the material to be processed is excessively softened, which is not suitable. The treatment time was set at 5 to 10,000 seconds because, for example, a sufficient effect for improving characteristics was not found at less than 5 seconds even at a high temperature on the order of 800°C

and when the treatment time exceeds 10,000 seconds, depending on the circumstances, there is excessive softening and the effect becomes saturated.

[0026] Preferred conditions in respect to the treatment temperatures and treatment times described above differ depending on the material of the copper alloy that forms the spring component. Below, we shall describe representative materials and treatment conditions. The copper alloy that is used for connectors is Cu-Ni-Si alloy (referred to as Corson alloy). Alloys are known that contain 1 to 4 wt% Ni and 0.1 to 1.0 wt% Si, with the balance being comprised essentially of copper. Copper alloy spring components are known in which the alloy described above also contains one or more elements selected from Sn, Mn, Mg, Zn, Ag and Co in a total mount of 0.005 to 2 wt% and in which the balance is comprised essentially of Cu. It is preferred that they are treated at an optimum temperature of 300 to 750°C and for a treatment time of 5 to 10,000 seconds. When treatment is performed at less than 300°C, there is insufficient improvement of the characteristics of the spring part. Conversely, when treatment is performed at higher than 750°C, the hardness differs before and after the heat treatment (the material is softened) to provide a value greater than 10. This is not desirable.

[0027] We shall now describe the brass material that is most frequently used as the copper alloy. It is preferred that spring materials that contain 5 to 35 wt% Zn and of which the balance is comprised essentially of copper are treated at an optimum temperature of 200 to 600°C and for a treatment time of 5 to 10,000 seconds. When treatment is performed at less than 200°C, there is insufficient improvement of the characteristics of the spring part. Conversely, when treatment is performed at higher than

600°C, the hardness differs before and after heat treatment (the material is softened) to provide a value greater than 10. This is not desirable.

[0028] Next, we shall describe the heat treatment that is performed after molding forming, which includes bending processing. Strictly speaking, the heat treatment conditions differ depending on the material to be processed. However, in general, when the difference in Vickers hardness before and after heat treatment is from –10 to 10, a desirable component in which there is little change in contact pressure over time can be manufactured. Here, the term hardness before heat treatment refers to the hardness of the site at which bending processing is performed and the hardness after heat treatment of the same site must be a comparison between the hardness before and after heat treatment at the same site. When the change in Vickers hardness exceeds 10 and softening occurs, there is sagging during insertion and withdrawal and stress relaxation is increased. This is not suitable.

[0029] There are also metal materials such as beryllium copper that are given heat treatment for bringing about aging hardening after molding forming, including bending. When these metal materials are further subjected to bending processing after aging hardening, they become excessively hard, cracking occurs in the part that has been bent and they cannot be processed normally. For this reason, in order to prevent cracking, aging hardening treatment is performed after bending processing. In this case, there is a large change in hardness of over 50 for Vickers hardness (Hv). The technique for effecting aging hardening after this bending processing differs from that of the invention in a technological sense and the aforementioned technique is not included in this application.

[0030] A copper alloy having the components described below is a metal material to which the forming and heat treatment described above can be applied. That is, it is a copper alloy for electric connector parts that contains one or two or more of the components listed below and the balance of which is comprised of Cu and unavoidable impurities ("0 wt%" indicated below signifying no addition).

Sn: 0-10 wt%	Zn: 0-40 wt%	Ni: 0-10 wt%
Fe: 0-3 wt%	Cr: 0-1 wt%	Mn: 0-1 wt%
P: 0-0.5 wt%	Si: 0-1 wt%	Mg: 0-1 wt%
Zr: 0-0.5 wt%	Ti: 0-1 wt%	Co: 0-1 wt%
Ag: 0-1 wt%	Al: 0-5 wt%	B: 0-0.5 wt%
rare-earth elements: 0-0.5 wt%		

[0031] Said alloys are described comprehensively. More specifically, it is preferred to use copper alloys having the following components. They are copper alloys for electric connector parts characterized in that they are copper alloys that are comprised of 1 to 4 wt% Ni and 0.1 to 1.0 wt% Si, with the balance being Cu and unavoidable impurities.

[0032] Further, it is preferred that said copper alloys for electric connector parts are copper alloys that contain 1 to 4 wt% Ni, 0.1 to 1.0 wt% Si, and, further, one or more elements selected from Sn, Mn, Mg, Zn, Ag and Co with a total weight of 0.005 to 1 wt% and in which the balance is comprised of Cu and unavoidable impurities.

[0033] It is further preferred that said copper alloys for electric connector parts are copper alloys that are comprised of 0.5 to 3 wt% Sn and 0.1 to 1.0 wt% P, with the balance being Cu and unavoidable impurities.

[0034] It is further preferred that said copper alloys for electric connector parts are copper alloys that contain 0.5 to 3 wt% Sn and 0.1 to 1.0 wt% P, and, in addition, one or more elements selected from Ni, Mn, Fe, Cr, Mg and Zn in a total amount of 0.005 to 2 wt%, with the balance being comprised of Cu and unavoidable impurities.

[0035] Said copper alloys for electric connector parts can also be copper alloys comprised of 3 to 10 wt% Sn and 0.005 to 0.5 wt% P in which the balance is Cu or unavoidable impurities.

[0036] Said copper alloys for electric connector parts can also be copper alloys that are comprised of 3 to 10 wt% Sn and 0.005 to 0.5 wt% P, and, in addition, one or more elements selected from Ni, Fe and Zn in a total amount of 0.005 to 2 wt%, with the balance being comprised of Cu and unavoidable impurities.

[0037] Copper alloys comprised of 5 to 35 wt% Zn, the balance of which is Cu and unavoidable impurities, can also be used as the aforementioned copper alloys for electric connector parts.

[0038] Copper alloys that contain 5 to 35 wt% Zn and, in addition, one or more elements selected from Sn, Ni and Fe and of which the balance is Cu and unavoidable impurities can also be used as said copper alloys for electric connector parts.

[0039]

[Working Example 1] Copper alloys of the compositions described in Table 1, labelled as Figure 4 (A: Corson alloy; B, C: bronze; D: brass) were used. Material of 0.25 mm in plate thickness was formed into a box-type female terminal as shown in Figure 1, and, after forming, heat treatment was performed under the conditions shown in Table 2, labelled as Figure 5. The conventional examples were cases in which heat

treatment was not performed and the comparison examples were cases in which the temperatures or heat treatment times were not suitable. Heat treatment was performed in a sealed, small electric furnace in which rapid heating and rapid cooling were possible. It was performed in a non-oxidizing atmosphere in a state in which a thermocouple was installed in the unformed material.

[0040] For evaluation of characteristics, evaluations were performed of hardness, sagging of the spring part and stress relaxation characteristics. The evaluation methods are described individually.

< Hardness > It is necessary to perform measurements at the site that acts as the spring and that has undergone bending processing. In order to measure the hardness of the bent part, the material to be formed is embedded in resin and measurements are made of sections after grinding. Three measurements were made starting from the center of the plate thickness of the bent part section toward the outer side in the radius direction. Measurements were also made in three places at sites that had not been subjected to bending and the differences in hardness before and after bending processing were found from the average values. Next, the Vickers hardness (Hv) after heat treatment was measured. The sites at which hardness was measured were the aforementioned bending processing regions. The change in hardness before and after heat treatment was found from the differences in the averages at the three points.

[0041] < Sagging spring part > Measurements were made several times of the gap referenced as gap (1) shown in Figure 1(B) in five samples after heat treatment and the average value A was found. The gap of gap (1) was similarly measured several times in

five samples into which the male terminal was inserted as shown in Figure 2 after heat treatment and from which the male terminal was removed after having been kept in place for 60 seconds and the average value B was found. The difference between A and B was the found and was taken as the sagging of the spring part after insertion and withdrawal of the male terminal.

[0042] < Stress relaxation characteristics > The male terminal was inserted into five samples after heat treatment and relaxation treatment was performed for 500 hours at 150°C in that state. After 500 hours had elapsed, the samples were removed from the treatment furnace, the male terminal was removed, the gap of gap (1) which was measured as shown by enclosure 1 was found, the average value C of the five samples was found and the difference between the aforementioned A value and C was found and taken as the amount of relaxation.

[0043] The aforementioned gap was measured by embedding the terminal in resin and grinding it, after which the cross section was observed. The results of the aforementioned measurements are recorded in Table 3, labelled as Figure 6. The differences in hardness before and after bending processing in all of the materials A to D at the sites of processing in this working example were less than 10. As can be seen from Table 3, labelled as Figure 6, Conventional Example Nos. 14 to 17, which were not subjected to heat treatment after molding forming, including bending processing, all exhibited sagging of the spring part and poor amounts of stress relaxation, The examples of this invention, Nos. 1 to 13, which were subjected to heat treatment after molding forming, exhibited extremely good characteristics.

[0044] There was softening to an Hv value of greater than 10, when compared to the value before treatment for the hardness after heat treatment of Nos. 19, 20, 23, 25 and 27, which had undergone high heat treatment temperatures and sagging of the spring part and deterioration in the amount of relaxation were found. Thus, it is important that the material to be processed is subjected to a heat treatment of an order at which softening is not excessive. Optimum heat treatment conditions differ depending on the material.

[0045]

[Working Example 2] Test strips (a, b and c) exhibiting differences in hardness in the bending processing of the aforementioned material C were prepared and the same tests were performed as in Working Example 1. The heat treatment conditions were the same as for No. 10 in Working Example 1. The results are shown in Table 4, labelled as Figure 7. The difference in hardness before and after bending processing of No. 30, which was originally a soft substance, was 12 and its characteristics as a spring were inferior to those of No. 28 and No. 29, which were examples of this invention. That is, these are examples in which the changes in hardness after bending processing were different, even in the case of identical processing, depended on the heat treatment conditions of the test strips before the bending processing and in which the spring characteristics were inferior under conditions outside those of this invention. Above, we have explained this invention in respect to the limitations on the copper alloy. However, in principle, they can also be applied, for example, to carbon copper and stainless steel copper.

[0046]

[Effect of the invention] As described above, when the forming and heat treatment method of this invention was applied to copper alloys for electric connector parts, there was an improvement in the sagging of the spring part and in the stress relaxation characteristics and it was possible to maintain contact pressure regularly at a high level. Further, there was little change in contact pressure over time, for which reason it was not necessary to design the initial contact pressure so that it was an at especially high level. Consequently, this measure contributed to a decrease in insertion force. Further, copper alloys to which said forming and heat treatment method is applied can be used for long periods as electric connector parts. Consequently, this invention makes a great contribution to industry.

[Brief Explanation of the Figures]

[Figure 1] This is a figure that shows an example of the shape of an electric connector part including a spring component.

[Figure 2] This is a figure that shows the state in which the male terminal and the female terminal of the electric connector part are connected.

[Figure 3] This is a figure that shows the site at which the hardness of the part that has been subjected to bending processing is measured.

[Figure 4] This is a figure that shows, as Table 1, the alloy compositions that were tested.

[Figure 5] This is a figure that shows, as Table 2, the heat treatment temperatures that were tested.

[Figure 6] This is a figure that shows changes in hardness before and after the heat treatments that were tested, the sagging of the spring part and the amounts of relaxation.

[Figure 7] This is a figure that shows, as Table 4, the relationship between changes in hardening before and after bending processing as well as spring characteristics when the material was subjected to bending processing as a spring component.

[Explanation of Symbols]

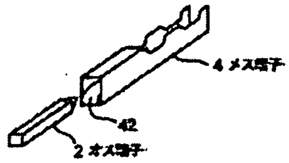
1 male terminal of the connector part

4 female terminal of the connector part

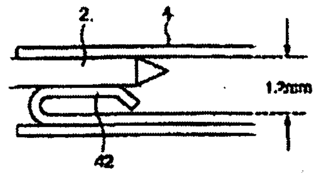
42 tongue piece of the female terminal

[Figure 1]

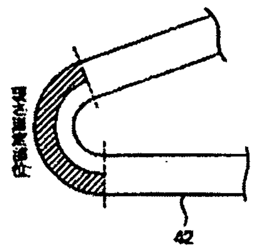
(A)



[Figure 2]



[Figure 3]



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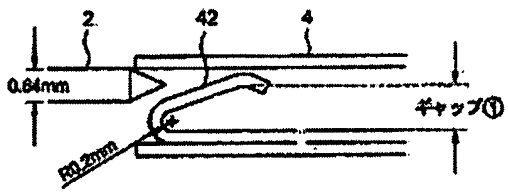

(A)
4 – female terminal
2 – male terminal

(B)
gap (1)

site of hardness measurement

[Figure 4]

Table 1

	Components (wt%)
Material A	Cu-2.5% Ni-0.6% Si-0.5% Zn-0.2% Sn-0.1% Mg
Material B	Cu-2% Sn-1% Ni-0.05% P
Material C	Cu-8% Sn-0.03% P
Material D	Cu-30% Zn

[Figure 7]

Table 4

	No.	Material used	Strip	Change in hardness (Hv) before and after bending processing	Change in hardness (Hv) before and after heat treatment	Sagging of spring part (mm)	Amount of relaxation (mm)
Examples of this invention	28	Material C	a	2	-2	0.06	0.14
	29	Material C	b	6	-1	0.09	0.12
Comparison example	30	Material C	c	12	-2	0.21	0.24

[Figure 5]

Table 2

	No.	Material used	Heat treatment conditions	
			Temperature (°C)	Time (seconds)
Examples of this invention	1	Material A	400	3600
	2	Material A	400	60
	3	Material A	400	300
	4	Material A	450	300
	5	Material A	500	300
	6	Material A	650	10
	7	Material B	280	3600
	8	Material B	330	300
	9	Material B	450	300
	10	Material C	330	300
	11	Material C	400	60
	12	Material D	230	300
	13	Material D	350	60
Conventional examples	14	Material A	no heat treatment	
	15	Material B	no heat treatment	
	16	Material C	no heat treatment	
	17	Material D	no heat treatment	
Comparison examples	18	Material A	250	3600
	19	Material A	820	5
	20	Material A	800	2
	21	Material A	350	18,000
	22	Material B	220	7200
	23	Material B	730	5
	24	Material C	180	7200
	25	Material C	690	5
	26	Material D	180	7200
	27	Material D	630	5

[Figure 6]

Table 3

	No.	Material used	Difference in hardness (Hv) before and after heat treatment	Sagging of spring part (mm)	Amount of relaxation (mm)
Examples of this invention	1	Material A	3	0.04	0.09
	2	Material A	-1	0.06	0.12
	3	Material A	1	0.05	0.10
	4	Material A	2	0.05	0.09
	5	Material A	-1	0.04	0.08
	6	Material A	-3	0.05	0.10
	7	Material B	-2	0.06	0.13
	8	Material B	-2	0.07	0.13
	9	Material B	-4	0.06	0.12
	10	Material C	-2	0.06	0.14
	11	Material C	-4	0.06	0.15
	12	Material D	-2	0.08	0.18
	13	-	-3	0.09	0.19
Conventional examples	14	Material A	-	0.09	0.17
	15	Material B	-	0.11	0.20
	16	Material C	-	0.10	0.22
	17	Material D	-	0.13	0.28
Comparison examples	18	Material A	1	0.08	0.16
	19	Material A	105	0.21	0.32
	20	Material A	-47	0.19	0.29
	21	Material A	4	0.06	0.13
	22	Material B	0	0.11	0.21
	23	Material B	-34	0.25	0.37
	24	Material C	-1	0.09	0.22
	25	Material C	-69	0.22	0.41
	26	Material D	-2	0.13	0.28
	27	Material D	-44	0.27	0.49

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(51) Int.Cl.[7]	Ident. Symbols	FI		(Reference)
C22C 9/06		C22C 9/06		
//C22F 1/00	630	C22F 1/00	630F	
	661		661A	
	685		685Z	
	691		691B	
			691C	